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DECORATIVE SHEET
[Kesho shiito]

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[Claim(s)]

[Claim 1] Decorative sheet prepared by sequentially laminating a printed ink layer, a transparent vinylchloride resin layer, a printed ink layer, and a transparent surface-protective layer on a nontransparent sheet.

[Claim 2] Decorative sheet according to Claim 1, wherein the surface protective layer having transparency provides the Haze value of 1 - 8% and the light transmissibility of 70% or higher within the range of 400 nm - 700 nm of wavelength.

[Detailed Explanation of this Invention]

[0001] [Industrial Application]

This invention relates to a decorative sheet providing the depth and three-dimensional effect.

[0002] [Description of the Prior Art]

Although various kinds of sheets providing the visual effect of depth are conventionally known, a sheet having a clear layer between a printed pattern layer and base layer for producing three-dimensional effects is frequently used as it can be easily manufactured.

[0003] [Problem(s) to be Solved by the Invention]

However, since the conventional decorative sheet has only one printed pattern layer, the depth and three-dimensional effect of the sheet are not sufficient.

[0004] This invention was developed in view of the above-mentioned problem. The object of this invention is to provide a decorative sheet capable of providing excellent depth and three-dimensional effect.

[0005] [Means for Solving the Problem]

In order to attain the above-mentioned object, the decorative sheet based on this invention is characterized by sequentially laminating a printed ink layer (hereafter called as a bottom printed ink layer), a transparent vinylchloride resin layer, a printed ink layer (hereafter called as a top printed ink layer), and a transparent surface-protective layer on a nontransparent sheet.

[0006] Moreover, the decorative sheet of this invention can be further enhanced when the surface protective layer having transparency provides the Haze value of 1 - 8% and the light transmissibility of 70% or higher in the range of 400 nm - 700 nm of wavelength.

[0007] In the above-mentioned configuration, the nontransparent sheet may be a plastic film, such as a polyvinyl chloride film, a polyvinylidene chloride film, a polyethylene film, a polypropylene film, a polyvinyl alcohol film, a polyethylene terephthalate film, a polycarbonate film, a nylon film, a polystyrene film, an ethylene vinyl acetate copolymerization film, an ethylene vinyl alcohol copolymerization film, an ionomer, etc.

[0008] As the desirable attribute of a nontransparent sheet, the sheet preferably has excellent color brightness or metallic glossiness or pearly glossiness. The reason for the preferable color brightness is probably because, when the top printed ink layer of the printed layers (described later) casts a shadow over the nontransparent sheet surface through the transparent vinylchloride resin layer, the shadow becomes more visibly recognizable. The white color is clearly preferable as the color of this nontransparent sheet; however, any color other than white color is usable as long as it is a light color. Therefore, when manufacturing a nontransparent sheet, the sheet is preferably colored by pigments mostly consisting of a white pigment or coated with a paint containing the pigments this property. Also, the reason for the preferable sheet surface having metallic or pearly glossiness is probably because, when the top printed ink layer casts a shadow over the nontransparent sheet surface through the transparent vinylchloride resin layer, the shadowed area can be clearly distinguished from the non-shadowed area, thereby providing the improved shadow visibility similar to the bright surface. To provide the metallic or pearly glossiness to the nontransparent sheet surface for accomplishing the above-mentioned object, when manufacturing a nontransparent sheet **1**, metallic powder or pearl powder (mica is usually used as substitution) is formulated into a sheet or kneaded in the sheet material. Moreover, a layer

having metallic or pearly glossiness may be provided to the back face of the transparent layer.

[0009] As the ink used for forming the top and bottom printed ink layers, if needed, an appropriate amount of coloring agent (e.g., pigment, dye, etc.), an extender, a solvent, a stabilizer, a plasticizer, a catalyst, a curing agent, etc., is mixed in the ink vehicle. The ink vehicle, in this case, is selected from thermoplastics, thermosetting resins, ionizing-radiation hardenable resins, etc. according to the application, required physical properties, printability, etc.

[0010] Examples of thermoplastic resin are cellulose derivatives, such as ethyl cellulose, cellulose nitrate, cellulose acetate, ethyl hydroxyethyl cellulose, cellulose acetate propionate, and the like; styrene resin or styrene copolymer, such as polystyrene, poly-α-methylstyrene, and the like; acrylic resin, such as polymethacrylic acid methyl, polymethacrylic acid ethyl, polyacrylic acid ethyl, polyacrylic acid butyl, and the like; vinyl polymer, such as polyvinylchloride, polyvinyl acetate, vinylchloride/vinyl acetate copolymer, polyvinyl butyral, and the like.

[0011] Examples of thermosetting resin are a phenol resin, urea resin, diallyl phthalate resin, melamine resin, guanamine resin, unsaturated polyester system resin, polyurethane system resin, epoxy resin, amino alkyd resin, melamine/urea copolymerized condensation

resin, silicone, polysiloxane resin, etc. A curing agent, such as a cross linking agent, polymerization initiator, a polymerization promoter, a solvent, a viscosity controlling agent, an extender, etc. are added to the resin if needed. As a curing agent, isocyanate is normally used with an unsaturated polyester type resin and polyurethane type resin; an amine is used with an epoxy resin; and peroxide (e.g., methyl ethyl ketone peroxide) and a radical initiator (e.g., azobisisobutyronitril) are commonly used with an unsaturated polyester type resin.

[0012] Examples of ionizing-radiation hardening resin are acrylate, such as urethane acrylate, polyester acrylate, etc., silicone, such as siloxane, polyester resin, epoxy resin, etc.

[0013] To prepare the top and bottom printed ink layers, the top printed ink layer is usually formed to the back face of the surface-protective layer having transparency, and the bottom printed ink layer is provided to the surface of nontransparent sheet. However, other techniques may be applied. The top/bottom printed ink layers can be formed by any conventional technique, such as gravure printing method, screen printing method, etc., using the above-mentioned ink. Moreover, the patterns may be printed in ink, or the technique of providing a pattern by utilizing vapor deposition of metal can be incorporated. To form a pattern utilizing a metal deposition film, for example, a water-soluble ink layer of selected pattern is formed on the surface of transparent resin layer, on which a metal is vapor-

deposited, and the surface is washed with water to remove the water-soluble ink and the vapor-deposited layer formed on the ink layer. This type of technique is included in the "pattern printing" described in this invention.

[0014] As the preferable characteristic of the bottom printed ink layer, since the pattern of the decorative sheet of this invention is configured of a combination of top printed ink layer pattern and bottom printed ink layer pattern, the printed ink layer is preferably capable of improving the intended design when the top and bottom patterns are overlaid to form an integrated design.

[0015] Examples of ink pigments are known coloring pigments, such as carbon black, cyanine blue, etc. and pearl pigment, such as titanium dioxide coated mica, etc. The design and pattern can be arbitrary selected from natural patterns, such as wood grain, stone grain, etc., symbolic patterns, such as water drops, stripes, etc. Moreover, a partially patterned metallic thin film layer of aluminum, chromium, or the like may be provided instead of applying a printed ink layer.

[0016] Examples of a surface protective layer having transparency are a vinylchloride resin, polyester resin, acrylic resin, polyester/acrylic copolymer, etc. In addition, if necessary, various conventional hard coat layers may be provided. For example, hard coat paint, such as polyester acrylate, urethane acrylate, etc., curable with an electron ray or an ultraviolet ray may be used.

[0017] The role of the above-mentioned surface protective layer having transparency is to protect the top printed ink layer and transparent vinylchloride resin layer while providing the durability and friction resistance to the surface of the decorative sheet.

[0018] Moreover, by allowing 1 - 8%, preferably 3 - 6% of the Haze ratio and at least 70% of light transmissivity within the wave length of 400 nm - 700 nm to the surface protective layer having transparency, the colors and patterns of the nontransparent sheet and top/bottom printed ink layers can stand out clearly and brightly with increased visual depth.

[0019] The Haze ratio (the degree of Haze) is the ratio of the diffused portion of light of the transmitted light, denoting the degree of hazing when an object is seen through the tester. The higher the Haze ratio, the dimmer the object becomes. If the total light transmissivity is set to Tt and the diffused transmissivity is set to Td, the value of Haze ratio (degree of dimming) H can be obtained by $H = (Td/Tt) \times 100(\%)$. If the Haze ratio is too small, the image becomes so sharp that even a small abrasion on the nontransparent sheet and transparent vinyl chloride resin layer is significantly emphasized. On the other hand, if the Haze value is below the prescribed value, the inner colors and patterns look jumbled, causing insufficient clarity of the image. As for the light transmissivity, if it is less than 70%, high image clarity is not

obtained. The upper limit of transmissivity is not particularly restricted.

[0020] As described above, the decorative sheet **1** of this invention consists of a nontransparent sheet **11**, lower printed ink layer **12**, transparent vinylchloride resin layer **13**, top printed ink layer **14**, and transparent surface protective layers **15** as shown in Fig. 1. The light emitted to this decorative sheet **1** is reflected from the respective surface of each layer, particularly from the nontransparent sheet **11**, the bottom printed ink layer **12**, and the top printed ink layer **14**. Among these reflections, the light reflected from the surface of top printed ink layer **14** forms patterned shadows of the top printed ink layer **14** on the surface of the nontransparent sheet **11** or the bottom printed ink layer **12**. Moreover, since the light reflected from the bottom printed ink layer **12** and the nontransparent sheet **11** is reflected or absorbed by the pattern of the top printed ink layer **14** depending on the viewed angle, the color and pattern of the bottom printed ink layer **12** and nontransparent sheet **11** become visible or invisible. These multilevel reflections and absorptions of light as well as the shadows and colors/patterns made visible or invisible by these reflections and absorptions of the light create synergic results to the decorative sheet 1 with excellent visual depth and three-dimensional effect.

[0021] In this case, by allowing 1 - 8%, preferably 3 - 6% of the Haze ratio and at least 70% of light transmissivity within the

wave length of 400 nm - 700 nm to the surface protective layer **15** having transparency, the decorative sheet **1** can provide high clarity to its surface color and patterns.

[0022] The above-mentioned decorative sheet **1** of this invention is created by mutually laminating the above-mentioned nontransparent sheet **11**, bottom printed ink layer **12**, transparent vinylchloride layer **13**, top printed ink layer **14**, and surface protective layer **15** having transparency. As a method of laminating these layers, a belting press method, a dry lamination process, thermo compression bonding, etc. can be used accordingly.

[0023] Since the depth and three-dimensional effect of the decorative sheet of this invention can be provided by the decorative sheet alone, these effects are not minimized when the sheet is applied on a metal plate, such as iron, aluminum, and copper, on a substrate of decorative board, such as various kinds of plastic sheets or wood plates (e.g., wood, plywood, particle board, etc.), on a plaster substrate, such as plaster board, plaster slag board, etc., on a fiber cement board, such as pulp cement plate, asbestos cement plate, wood piece cement plate, glass fiber reinforced cement, or on concrete, etc.

[0024] [Operational example]

The following describes the operational examples of this invention for more concretely explaining this invention. Note that the scope of this invention is not limited to these examples.

[0025] (Example 1)

Figure 2 is a diagram illustrating an operational example of the decorative sheet based on this invention. Hereafter, the production process of this decorative sheet is explained.

[0026] First, while a printed ink layer **22** was formed on a 0.1 mm thick nontransparent colored polyvinyl chloride film **21** ("B-2000 type" by Bando Chemical Industries, Ltd.) with photogravure ink (Chemical X type by Showa Ink Kogyosho), a printed ink layer **24** was formed on a 0.1 mm thick unplasticized transparent polyvinyl chloride film **25** ("B-2000 type" by Bando Chemical Industries, Ltd.) with photogravure ink (Chemical X type by Showa Ink Kogyosho). Then, the reverse side of this printed ink layer **24** was coated with a UV coat layer. As a result, a transparent protection film was prepared.

[0027] By positioning the above-mentioned printed ink layers **22** and **24** to face each other, the vinyl chloride film **23** with a thickness of 0.4 mm was put between the colored polyvinyl chloride film **21** and the unplasticized transparent polyvinyl chloride film **25**. Then, these layers were laminated by a belting press method for creating a decorative sheet. As a result, a decorative sheet having visual depth and three-dimensional effect could be obtained.

[0028] (Example 2)

Figure 3 is a diagram illustrating an operational example of the decorative sheet concerning this invention prepared by laminating a

decorative sheet on a steel plate. Hereafter, the creation process of this decorative steel plate is explained.

[0029] First, a polyester film **37** ("S-30" by Toray Industries, Inc.) with a thickness of 25 μm was coated with a UV coat layer for preparing a transparent protective layer **38** having 3% of Haze ratio and 90% of light transmittance. Next, photogravure ink ("Chemical X type" by Showa Ink Kogyosho) was applied to the back face of this polyester film surface so as to create a printed ink layer **36**. Then, a transparent vinyl chloride film **34** ("B-2000 type" by Bando Chemical Industries, Ltd.) having a thickness of 0.1mm (thermal melting layer **34**) was dry-laminated to this printed ink layer **36** using urethane two-liquid type adhesives **35** (by Dainippon Seikasha).

[0030] On the other hand, photogravure ink ("Chemical X type" by Showa Ink Kogyosho) was coated to the nontransparent colored polyvinyl chloride film **31** ("B-2000 type" by Bando Chemical Industries, Ltd.) having a thickness of 0.1 mm in order to create a printed ink layer **32**.

[0031] Then, the transparent vinyl chloride film **33** having a thickness of 0.4 mm was inserted between the thermal melting layer **34** side and printed ink layer **32** side of the nontransparent colored polyvinyl chloride film **31** of the above-mentioned laminate body consisting of the transparent protective layer **38**, printed ink layer **36**, and thermal melting layer **34**. Then, the layers were laminated by a belting press method. Hence, a decorative sheet was produced.

[0032] This decorative sheet was adhered to a steel plate **39** having a thickness of 0.6 mm with adhesives **40** and used as the surface material of a refrigerator. The prepared surface could provide visual depth and a three-dimensional effect.

[0033] [Effect of the Invention]

As described above, since the decorative sheet of this invention is prepared by providing a printed ink layer to the top and bottom surfaces of a thick transparent vinylchloride resin layer on a nontransparent sheet. Therefore, the incident light is reflected from and absorbed by multilevel layers, making the shadows, colors, and patterns visible and invisible. Hence, these effects can provide synergic results to the visual depth and three-dimensional effect to the decorative sheet.

[0034] Moreover, by allowing 1 - 8%, preferably 3 - 6% of the Haze ratio and at least 70% of light transmissivity within the wave length of 400 nm - 700 nm to the surface protective layer having transparency, the decorative sheet 1 can provide high clarity to the colors and patterns.

[Brief Description of the figures]

[Figure 1] Cross-sectional diagram for explaining the decorative sheet of this invention.

[Figure 2] Cross-sectional diagram of the decorative sheet of this invention.

[Figure 3] Cross-sectional diagram illustrating the condition of laminating the decorative sheet concerning this invention on a steel plate.

[Description of Notations]

1…Decorative sheet; 11…Nontransparent Sheet; 12…Printed ink layer (Below); 13…Transparence Vinyl-Chloride-Resin Layer; 14…Printed ink layer (above); 15…Surface Protective Layer

Figure 1

Figure 2

Figure 3